8-12-1959

An Aeromagnetic and Geologic Reconnaissance Survey of the Sidney - Augusta and Gardiner Areas : Kennebec County, Maine

Lawrence A. Wing

GP & G SURVEY #5

AN AEROMAGNETIC AND GEOLOGIC RECONNAISSANCE SURVEY OF THE SIDNEY - AUGUSTA AND GARDINER AREAS KENNEBEC COUNTY, MAINE

MAINE GEOLOGICAL SURVEY

ROBERT G. DOYLE, STATE GEOLOGIST

DEPARTMENT OF ECONOMIC DEVELOPMENT

AUGUSTA, MAINE - AUGUST 12, 1959

GP & G #5

AN AEROMAGNETIC AND GEOLOGIC RECONNAISSANCE SURVEY OF THE SIDNEY - AUGUSTA AND GARDINER AREAS KENNEBEC COUNTY, MAINE

By

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Old Town, Maine

Maine Geological Survey

Robert G. Doyle, State Geologist

Department of Economic Development

Augusta, Maine - August 12, 1959

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INTRODUCTION

A geologic and aeromagnetic reconnaissance survey of two small areas in the vicinity of Augusta and Gardiner, Maine, was performed by the James W. Sewall Company for the Maine Geological Survey during the period July - August, 1959. The combined areas total approximately 80 square miles. The Geologic problems and the survey results are quite different for the two areas and they are described as Part I - Augusta-Sidney Area and Part II - Gardiner Area in this report.

PART I AUGUSTA - SIDNEY AREA

The northern part of this area is fairly well exposed and geologic mapping has indicated a number of well defined lithologic units and has strongly suggested the presence of several fold axes. The central and southern parts of the map area are almost completely covered by a thick mantle of glacial soils and it was anticipated that an airborne magnetic survey might serve as a distinct aid to detailed geologic mapping, especially in the obscured areas.

PREVIOUS WORK

There are several references to the area included in the present map or immediately adjacent. Perkins (1924) describes a graptolite locality somewhat to the north and has also, Perkins (1925), described a geologic section from the Kennebec River to Penobscot Bay. Trefethen (1932) mapped the Hallowell intrusives and his map shows the northern contact of the granite slightly west and south of Augusta. Hurley and Fairbairn (1957) have investigated amounts of uranium and thorium in sphene, apatite, and monazite in samples taken from the Hallowell quarries. Hurley (1958) - in a study of ages includes the Hallowell granite in a group averaging 385 million years or post-Early Middle Devonian. Osberg (1958) in a preliminary report has mapped and described the northern part of the area in considerable detail and his map is reproduced in this report as the Geologic Sheet. The work by Osberg will continue into the unmapped portions of the sheet. Most of the descriptions of rock units and structure which follow are taken directly from the preliminary report by Osberg.

FIELD AND COMPILATION PROCEDURE

The various maps appended to Part I of this report and the methods used to acquire data for the maps are briefly described as follows:

Base Sheet - The base map was prepared from the fifteen minute U.S.G.S. quadrangles Augusta and Vassalboro. Road detail, buildings, and the twenty foot contours have been deleted.

Photo Index Sheet - The photographic index shows approximate flight lines and photo centers for photography available for the map area. The photographs are available for purchase as indicated on the photo index legend.

Flight Line Sheet - The flight line sheet shows all lines flown during the magnetic survey. A few control points are also included although all positioning and plotting of flight lines was actually done on a photographic mosaic and the final results then transferred to the maps.

Magnetic Sheet - The magnetic sheet and the magnetic profiles are based on work done with a Varian Nuclear Precession Magnetometer, model V-4910, mounted in a Cessna 180 aircraft. The magnetic survey was flown at a mean distance of 500 feet above the terrain. The 0.7 second measuring cycle of the instrument is equivalent to measuring total intensity at intervals of from 100 to 130 feet. The position of the aircraft during flight was recorded by a 35 millimeter camera taking vertical overlapping photographs on a one second interval. Photographic numbers from the film are correlated directly with the magnetic and altimeter records and thus the magnetic value at any point can be transferred to photo mosaics and final maps.

The magnetic data is presented as a contoured sheet and as a plate of selected profiles. Since this small area was flown over a short span of time no diurnal correction has been needed.

Geologic Sheet - The geologic sheet has been modified only to a very minor extent from the preliminary map by Osberg (1958). Since this work by Osberg will continue the present interpretation has not extended his original work. Some comments on geology as related to magnetic results are included in some of the later paragraphs.

Profile Plate - Three flight lines were selected to demonstrate or suggest correlation between geology and total magnetic intensity. Two of these lines cross the known or closely inferred sedimentary sequence and the third crosses the granite boundaries to the south in an area of few exposures.

GENERAL GEOLOGY

The rocks of sediment origin underlying the Vassalboro - Augusta area have been grouped into three formational units by Osberg (1958). The younger of these, the Palmyra formation, does not extend as far south as the limits of the present map but the Vassalboro formation (oldest) and the overlying Waterville formation are both present as is the still younger intrusive binary granite.

The present interpretation for the stratigraphic order of sediments and the distribution of exposures makes the general structure that of a northward plunging syncline with the base of the Vassalboro unknown. At least three and possibly four lesser fold axes lie between the two limbs of the larger fold bounded by the Vassalboro formation.

The degree of metamorphism increases southward toward the granite but according to Trefethen (1932) very little in the way of metamorphic effects can be attributed to the intrusive mass.

DESCRIPTION OF FORMATIONS

The sedimentary units are described below on the basis of appearance in outcrop and hand specimen since chemical and microscopic data are not available. The granite is described on the same basis with the addition of some microscopic study as reported by Trefethen (1958).

Vassalboro formation - The Vassalboro formation was originally described by Perkins (1925) as a fine-grained, massive, blue-grey sandstone interbedded with grey shale. The rock is slightly limey in the sandy portions. The base has not been mapped and the thickness is unknown but Osberg (1958) estimates it to be in the order of hundreds of feet.

Waterville formation - The Waterville formation includes six lithologic sub-units, five of which outcrop within the present map area. The lowest of these six units is the transition from the Vassalboro formation and consists of one to three inch beds of medium grey quartzite interbedded with medium grey quartz-biotite phyllite. This basal unit is overlain conformably by a dark grey phyllite containing considerable pyrite and pyrrhotite. It weathers to a characteristic black surface stained with limonite.

Light green phyllite lies above the dark phyllite and contains thin alternating beds of quartzite. In areas of higher metamorphic grade this unit becomes a coarser grained schist in which chlorite gives way to biotite.

Waterville Formation Cont'd:

The light green phyllite grades upward into a unit made up of thin bedded quartzite interbedded with slightly thicker biotite phyllite and schist. In areas of higher metamorphic grade garnet is present in the schistose portions of the unit.

The top unit present within the boundaries of the present map is made up of two to three inch beds of grey argillaceous limestone alternating with medium grey biotite phyllite. On weathered surfaces the phyllitic layers stand out as small ridges.

A light grey quartzite and phyllite unit makes up the top of the Waterville formation but does not outcrop in the area included in this survey.

The thickness of the above units is in the order of several tens of feet each with a total thickness for the Waterville formation of perhaps up to several hundred feet.

Granite - The Hallowell granite outcrops near the southern limit of the map. The rock is generally light grey with a medium to fine texture. Some coarser grained phases are present and border zones locally become porphyritic and may contain black tourmaline. Biotite and muscovite are present in about equal percentages and in the vicinity of the Hallowell quarries show some parallelism.

MAGNETIC SURVEY DISCUSSION

Study of the magnetic sheet and profiles in respect to the known geology brings out several points of interest. The primary aim of the magnetic survey was to aid in extending the geologic boundaries and rock units to the south and southwest in areas of heavy overburden and it was assumed that the response over the dark phyllite member of the Waterville formation might prove useful in this sense. As seen in both plan and profile this assumption proved to be valid with a pronounced magnetic high over this unit. On this basis it would appear that:

1. The easternmost band of dark phyllite might be extended northward about one mile and that the southern end as now mapped is essentially correct with a possible very slight shift to the east.

2. The central band can apparently be made continuous through the gap in its northeasterly end with a slight shift to the east. The southern end could be extended perhaps one more mile with a slight flexure as shown on the magnetic plan view. There appears to be little reason for extension of the eastward split in the central part of this belt.

3. The western belt shown as sharply folded on the north end is north of the limits of the magnetic survey. About one mile south from the north edge of the map the magnetic anomoly is about one-quarter mile west of the unit as shown on the geologic map, however, at this point the magnetic high turns in direction from southwest to south crossing the dark phyllite unit.

4. A fourth belt of dark phyllite appears about one mile easterly from Messalonskee Lake on the very northern edge of the map. A minor magnetic high, between two depressions could be connected to this unit and possibly continued by folding to meet the southern extension of the unit described in 3. above. In this event the horizontal projection of the minor fold axis between these two exposures would have a southwesterly trend at the north edge of the map which would curve around to nearly due south and close about two miles to the south. Other interpretations are certainly possible in this part of the map and the structural picture may be improved considerably after more field work in this immediate area and to the west and northwest.

Two other features, in addition to the magnetic ridge associated with the dark phyllite, deserve further mention. The striking magnetic ridge through Messalonskee Lake and to the southwest is appreciably higher and more continuous than those previously mentioned. No explanation for this anomoly is available at the present state of mapping. It is entirely in what has been mapped as Vassalboro yet existing descriptions of this formation offer no hints as to what might be the cause of the magnetic high. It is interesting to note that a roughly similar high apparently exists on the east side of the Kennebec and about parallel to the river. This anomoly on the east side of the river is outside the survey limits and for the most part outside the map and since the tracking camera was not in use during the long turns between lines in this area neither the exact location nor the character of the anomoly can be known with certainty. It does however, look as if a distinct magnetic unit is present in the Vassalboro on both sides of the map and this does at least tend to substantiate the present general map interpretation.

The other point of interest, based on the magnetic sheet, is the rather abrupt change in the southern part of the map to a pronounced, somewhat irregular trend northwest and southeast in contrast to the dominant northeasterly trend over the remainder of the map. It would appear likely that the margin of the granite as mapped is quite approximate and that the irregular magnetic terrace represents the true contact zone.

CONCLUSIONS

While this survey represents a rather small area and restricted group of rock types it does bear out the fact that magnetic surveys may be used as an aid to detailed geologic mapping as well as for reconnaissance and exploration surveys. Additional field work and time will be needed to properly evaluate its usefullness in this particular area. It also now seems that carefully plotted magnetic profiles with a more open line spacing might be as useful, if not more useful, to the field geologist in this particular type of work.

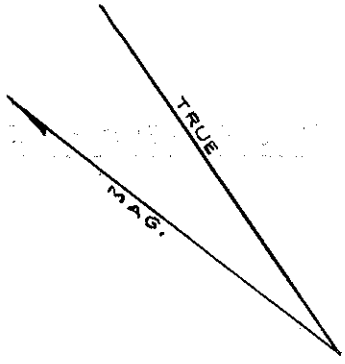
If this technique were to be expanded to larger areas for the same end objectives it would be necessary to remove diurnal variations with considerable care while uncorrected profiles might more economically serve the same purpose.

The sulphide bearing phyllite represents only one of a number of rock types as well as structural features that can be clearly delineated from airborne magnetic surveys as well as other geophysical techniques. Expanded use of such methods in heavily covered terrain combined with normal ground mapping methods seems likely to yield far more accurate information with little, if any, increase in cost than either method employed alone.

MAP APPENDIX I

AUGUSTA - SIDNEY AREA

BASE SHEET
AUGUSTA - SIDNEY AREA



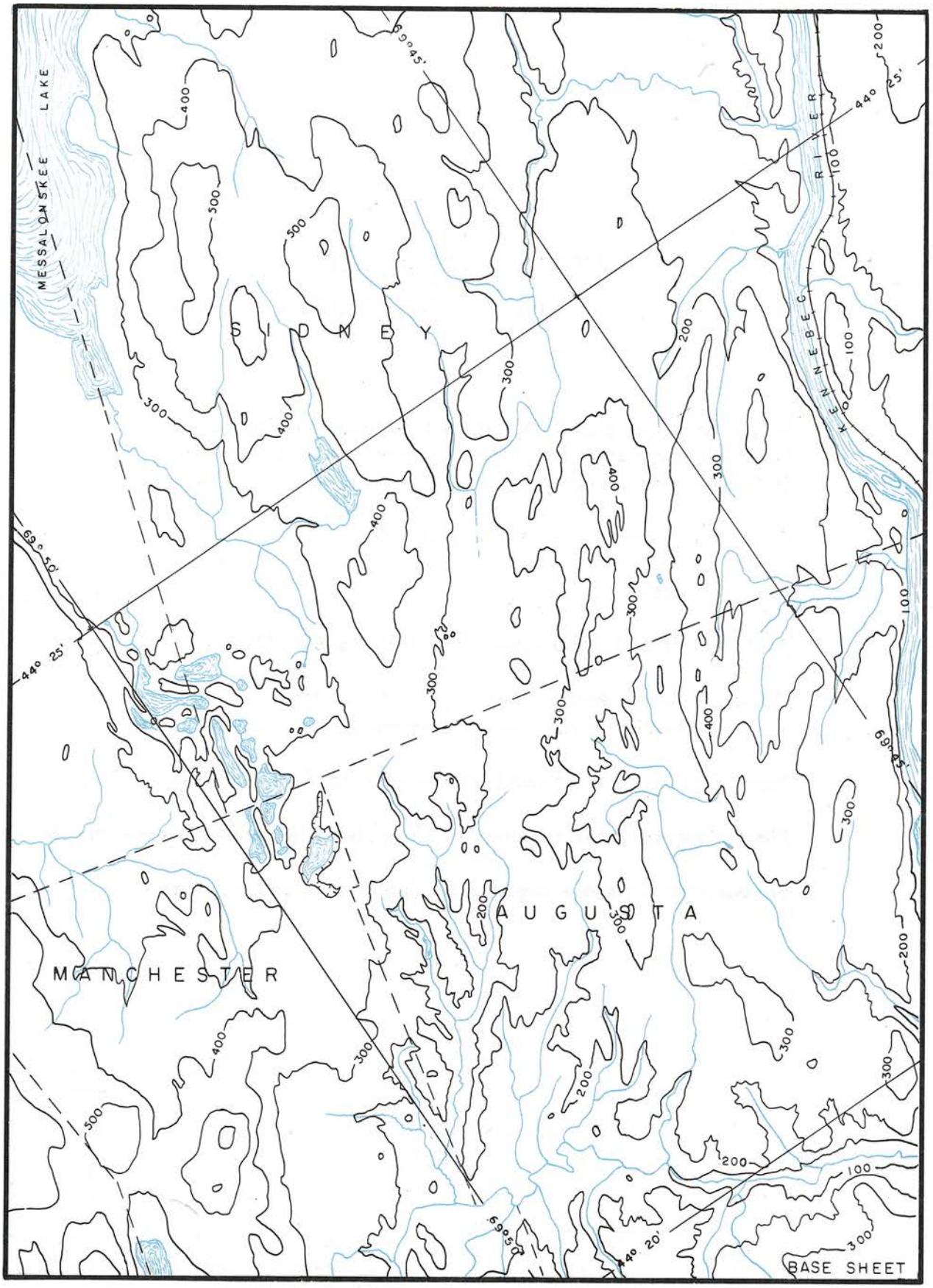

MESSALONSKEE LAKE
SIDNEY
KENNEBEC RIVER
AUGUSTA
MANCHESTER
69°45'
69°50'
44° 25'
44° 20'
BASE SHEET

PHOTO INDEX SHEET

Flight lines and photo centers as inicated, the first number listed corresponds to the flight line and the second to the individual photograph

Code designation for ordering MOP

Flown in 1956

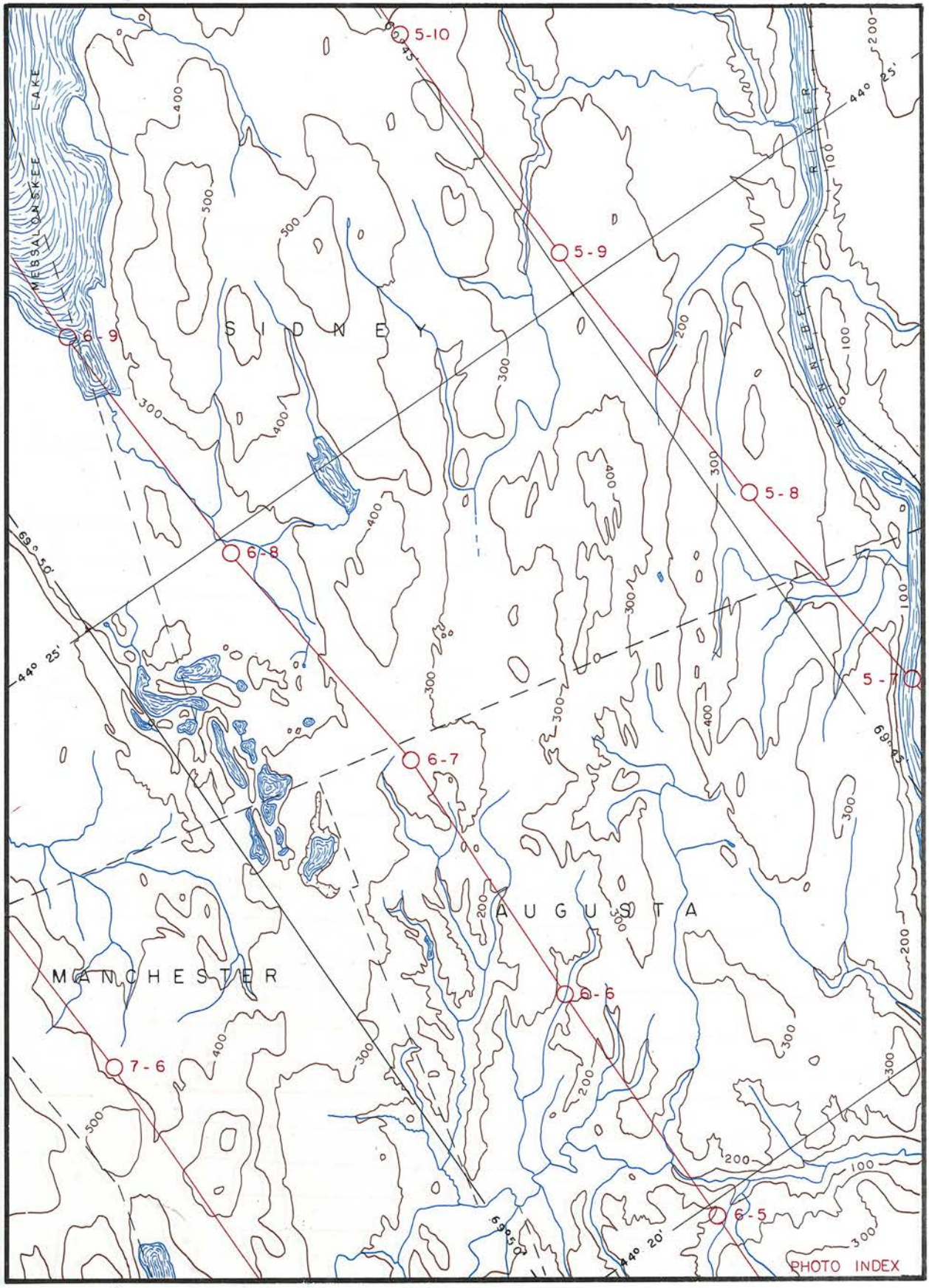
Scale 1:31,680 Approximately 1 inch equals 1/2 mile

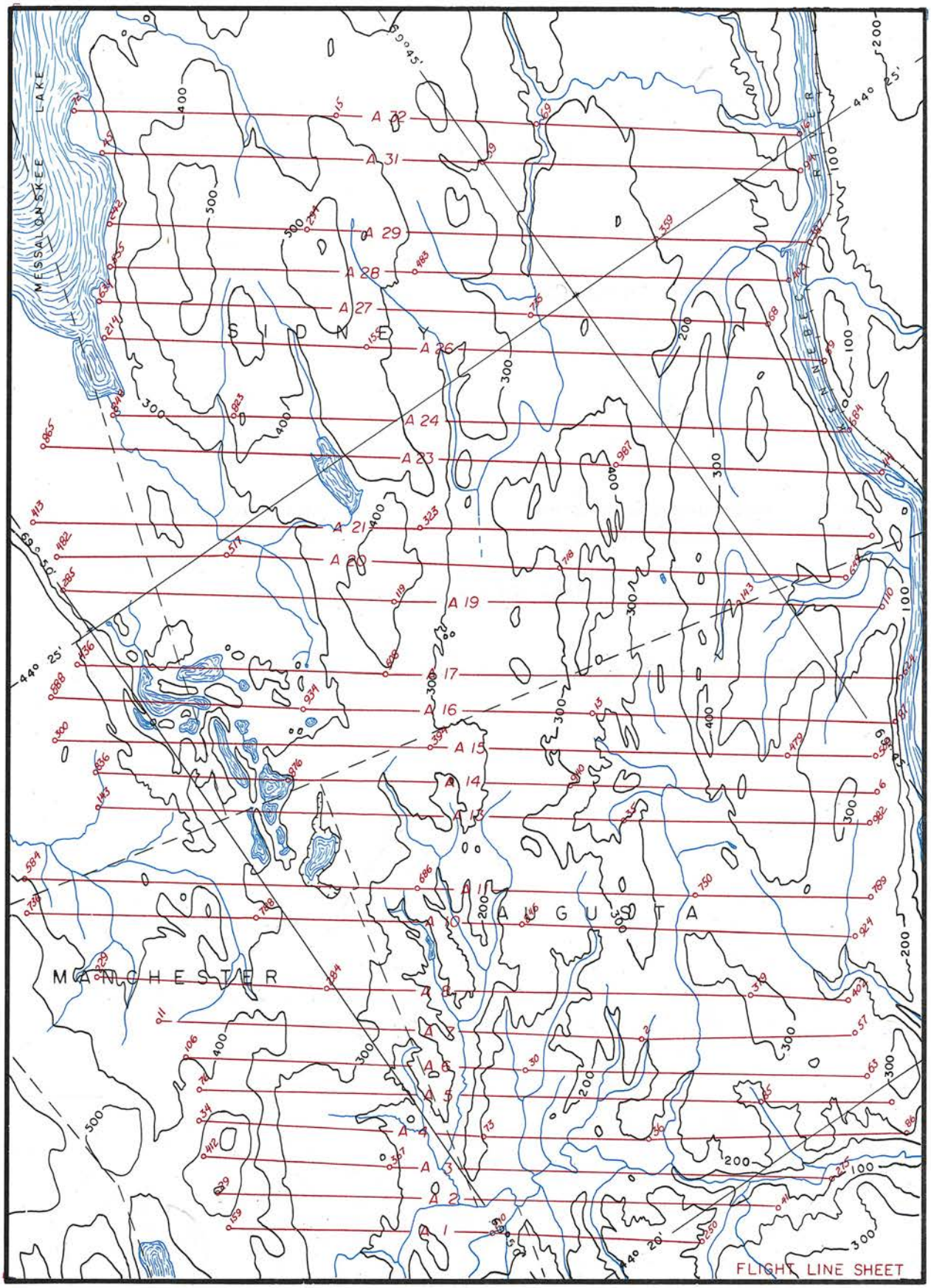
Owner: Oxford Paper Company, Rumford, Maine
Permission required to purchase

Taken By: James W. Sewall Company, Old Town, Maine

Planimetric coverage requires all flight lines but only alernate photos

Stereoscopic coverage requires all flight lines and all photos


5-10
5-9
5-8
5-7
6-9
6-8
6-7
6-6
6-5
7-6
S I D N E Y
A U G U S T A
M A N C H E S T E R
MESALONSKEE LAKE
KENNEBEC RIVER
69° 45'
69° 50'
440 25'
440 20'
PHOTO INDEX


MESSALONSKEE LAKE
SIDNEY
MANCHESTER
AUGUSTA
NEBECK RIVER
A 32
A 31
A 29
A 28
A 27
A 26
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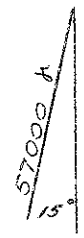
A 23
A 21
A 20
A 19
A 17
A 16
A 15
A 14
A 13
A 12
A 11
A 10
A 8
A 7
A 6
A 5
A 4
A 3
A 2
A 1
FLIGHT LINE SHEET

MAGNETIC SHEET

Flight Altitude 500 feet



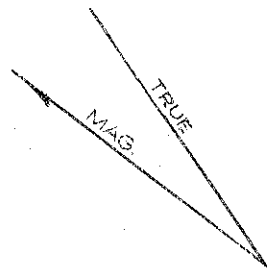
Approximate inclination
and total intensity

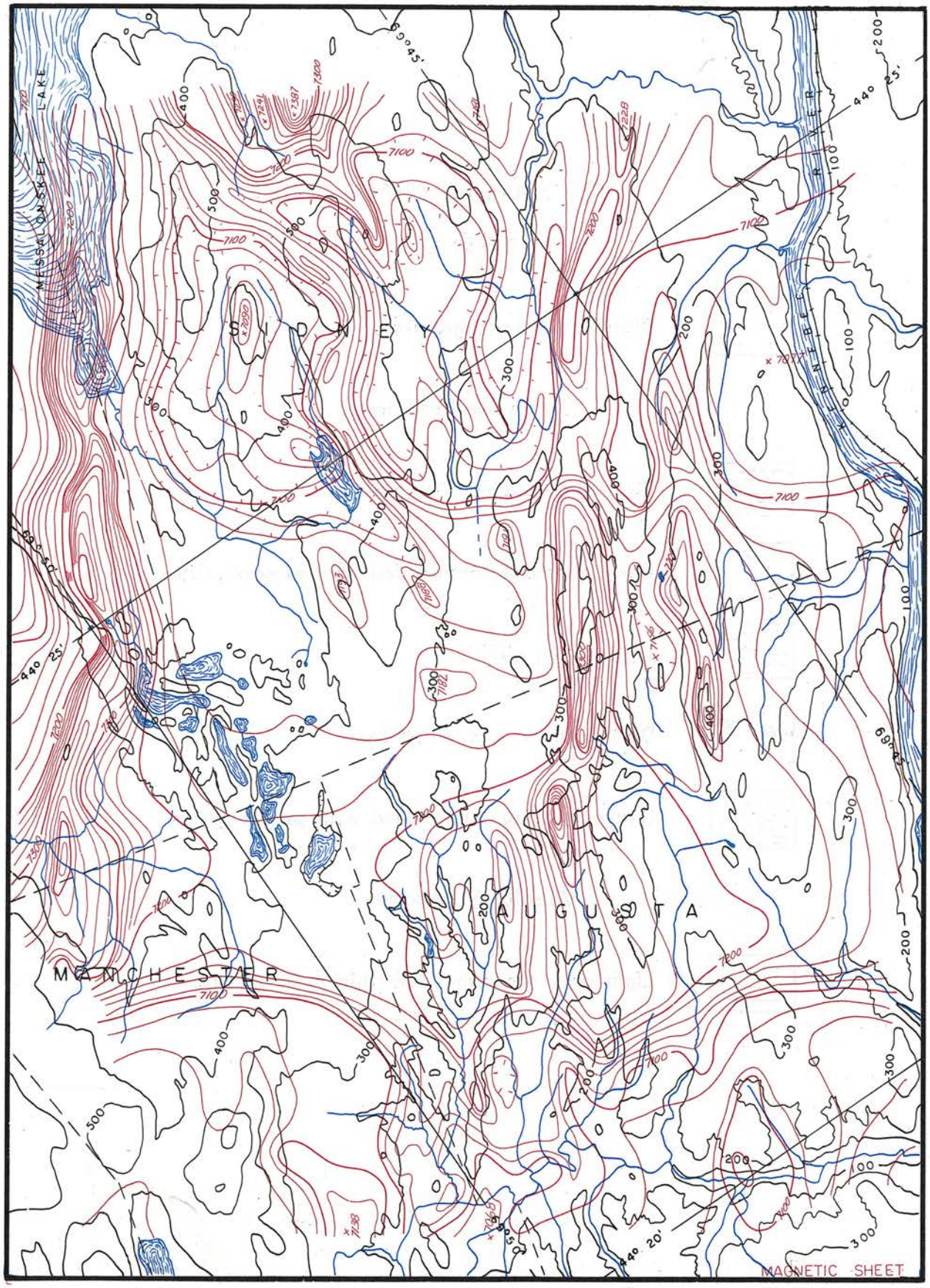
Line Interval 1/4 mile

Approximate mean
declination 1959

Regional magnetic values

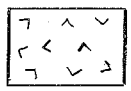
Contour interval 20 gammas based on total intensity less 50,000 gammas




MISSALONSKEE LAKE
SIDNEY
KENNEBEC RIVER
AUGUSTA
MANCHESTER
MAGNETIC SHEET

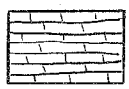
GEOLOGIC SHEET

LEGEND

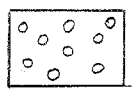


Biotite muscovite granite

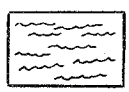
Waterville formation



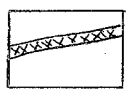
Grey thin-bedded limestone



Grey quartzite interbedded with grey phyllite



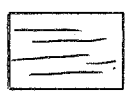
Light green phyllite



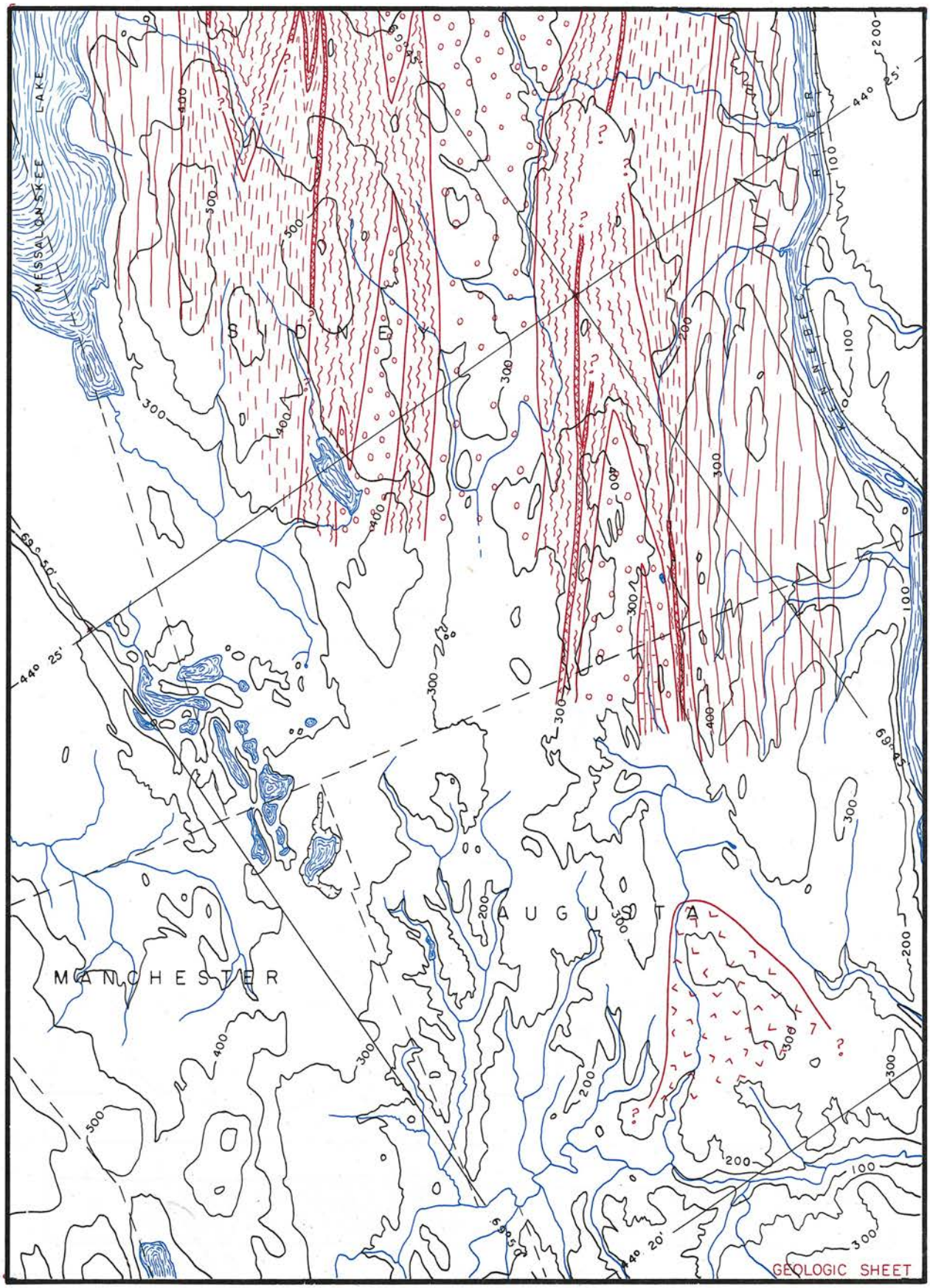
Dark phyllite with sulphides

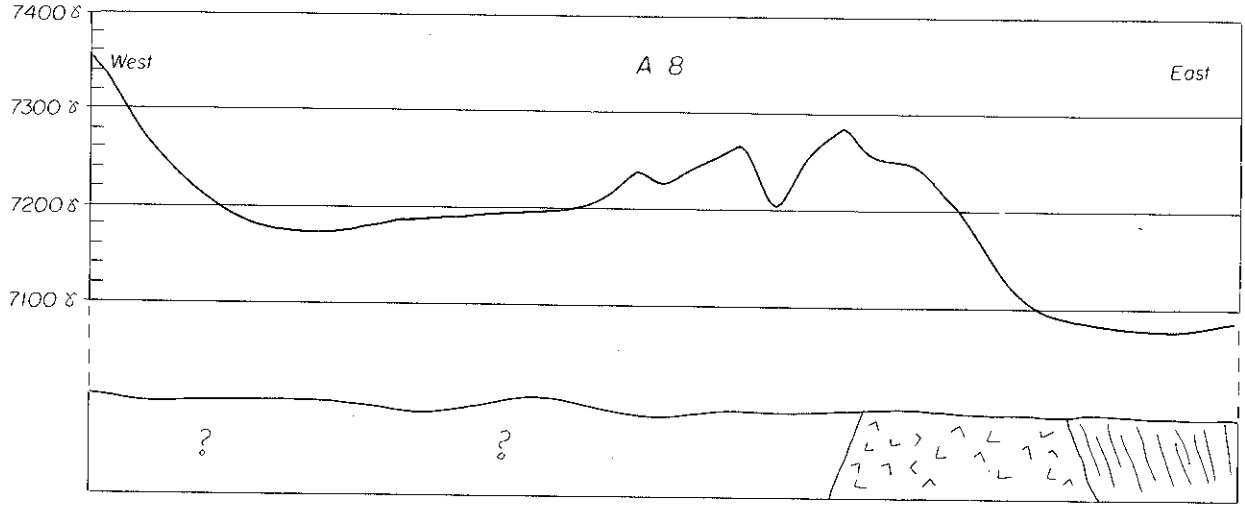
Grey quartzite interbedded with grey phyllite

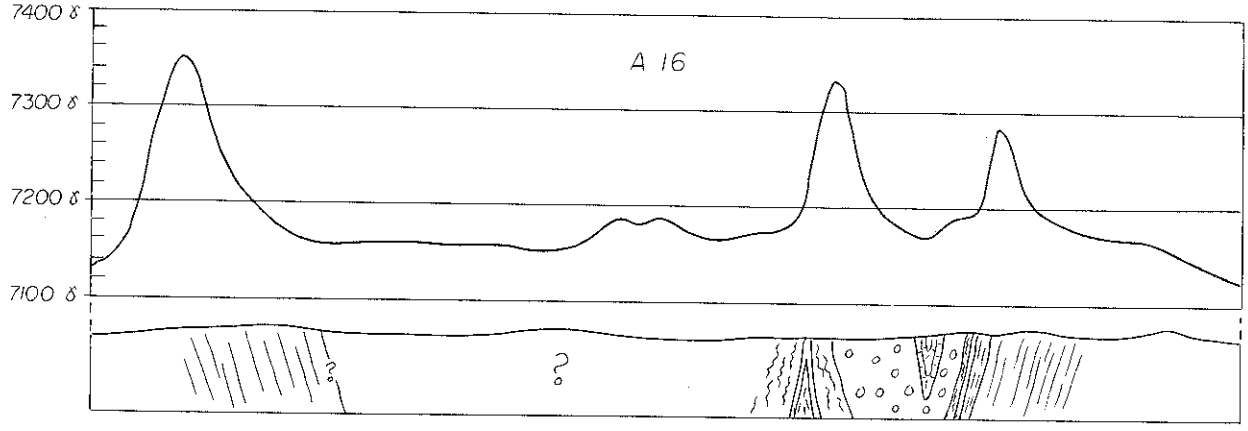
Vassalboro formation

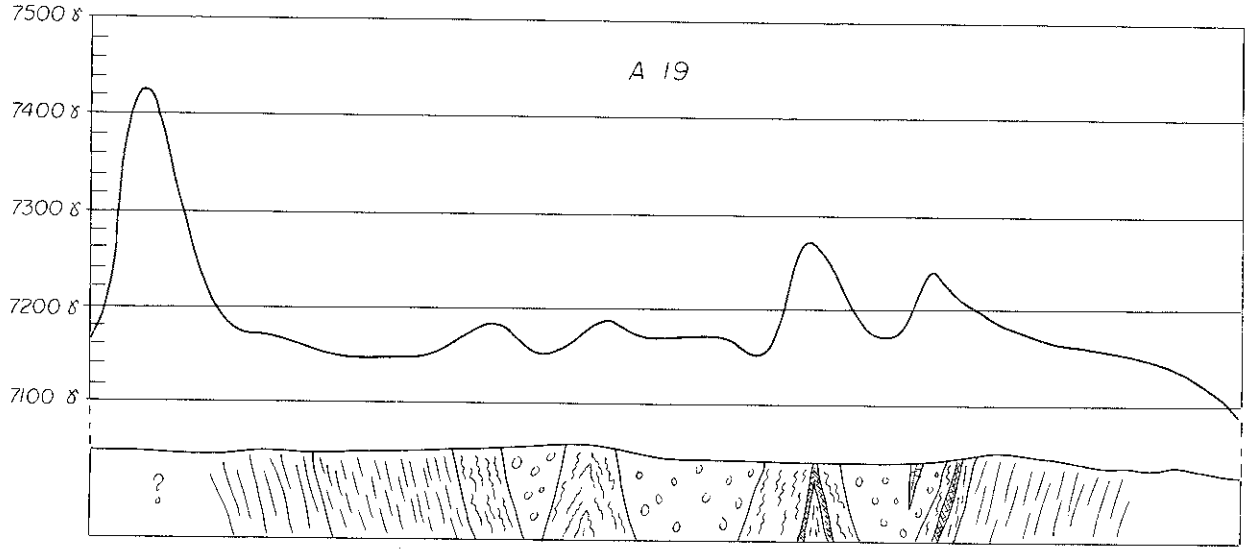


Light grey sandstone with thin grey phyllite


MESSALONSKEE LAKE
SIDNEY
AUGUSTA
MANCHESTER
KENNEBEC RIVER
GEOLOGIC SHEET







MAGNETIC – GEOLOGIC PROFILES
See geologic sheet legend for symbols

PART II - GARDINER AREA

Pyrrhotite mineralization as both massive veinlets and disseminated grains has long been known from the schistose rocks immediately south from the City of Gardiner. The small hill in which the mineralization is apparent derives its name, Iron Mine Hill, from the occurrence. The extent of mineralization and the possibility of associated economic elements has never been well known. Ten rather closely spaced magnetic flight lines and ground reconnaissance was carried out in an attempt to outline the boundaries and obtain some idea as to size of the mineralized zone.

PREVIOUS WORK

The occurrence of pyrrhotite in this area has probably been known from the time of the earliest settlers in the region and it is mentioned in several of the older papers. The first description with a map is by Forsyth (1955) involving several dip needle traverses and outcrop examination. Doyle (1959) spent several days in reconnaissance of the area during the present survey and the appended geologic map was compiled from data available from both of the above mentioned sources and brief field examination by the writer in 1957.

FIELD AND COMPILATION PROCEDURE

The maps appended to Part II of this report were compiled in the same manner as those of Part I and the text description is not reproduced here. A Photo Index Sheet has not been included since complete stereoscopic coverage can be obtained from three photographs, the data for which are as follows:

Designation	-	SDW Line 25 Photos 5, 6, and 7
Scale	-	1:31,680 (1 inch = 1/2 mile)
Date	-	June, 1955
Owner	-	S. D. Warren Company Cumberland Mills, Maine Permission required to purchase
Taken By	-	James W. Sewall Company Old Town, Maine

GENERAL GEOLOGY

The rocks of the immediate area have been subjected to considerable metamorphism and deformation and the sedimentary sequence north of Augusta cannot be readily carried down into this area. From field work carried out to date it appears that three metamorphic types and a granite may constitute the mappable units as they are shown on the appended Geologic Sheet. The oldest of these is apparently the quartz-biotite schist in which the sulphide schist may occur as a member near the top. The quartz-biotite schist is overlain by the granitic gneiss and the boundary between the two is not clearly defined. Many small pegmatites and granitic veins have been introduced into the granitic gneiss and this unit may only represent that part of the quartz-biotite schist lying in close proximity to the granite.

Little is known about the granite which appears to be the youngest rock of the area. It is similar to some of the Hallowell granite but according to the map by Trefethen (1952) is not a part of the same mass.

MINERALIZATION

Pyrrhotite occurs as both disseminated elongate grains and as narrow massive veins closely spaced over zones up to six feet thick. Some pyrite and rare chalcopyrite have also been seen and graphite is common. Forsyth (1955) reports faint qualitative tests for nickel and also reports that not enough was present to be identified by assay.

No laboratory separations have been made on large samples to determine the amount of pyrrhotite or associated minerals.

MAGNETIC SURVEY DISCUSSION

Examination of the magnetic sheet indicates that the sulphide bearing horizon is the unit producing a pronounced magnetic anomoly and extensions of the sulphide zone have been inferred on the geologic sheet on the basis of this anomoly. The magnetic peaks as viewed in cross-section are nearly symmetrical, this coupled with foliation attitude as seen in the field indicates the probable zone of mineralization to be nearly vertical. This vertical attitude and also the nature of the mineralization may not hold true on the noses of the folds as inferred on the geologic sheet and unfortunately neither magnetic nor geologic data are available for these local areas.

CONCLUSIONS

Both the outcrops available and the magnetic data strongly suggest the zone of sulphide mineralization to be confined to a thin elongate zone rather than rounded as shown on the map by Forsyth (1955). The configuration of the zone indicates that it probably represents an original sedimentary bed. The sulphide bearing dark phyllite of Augusta, as described in Part I, is geographically close and roughly geologically on strike with the Gardiner area and it seems highly likely that the sulphide schists at Gardiner are equivalent to the sulphide phyllites at Augusta.

Additional work is needed in this area both from the geologic and economic viewpoints as follows: (1) The folded structure with the syncline to the north and anticline to the south, both plunging southwesterly, is highly interpretative and should be evaluated more closely in the field. (2) Trace element study of the sulphide horizon at Gardiner and Augusta might help in correlation since what appears to be a similar horizon well north of Augusta shows a highly abnormal enrichment in silver. (3) Economically it would appear that the nose of the syncline where cut off by the granite deserves further investigation for base metals and (4) The magnetic peak southwest from Iron Mine Hill also deserves additional study.

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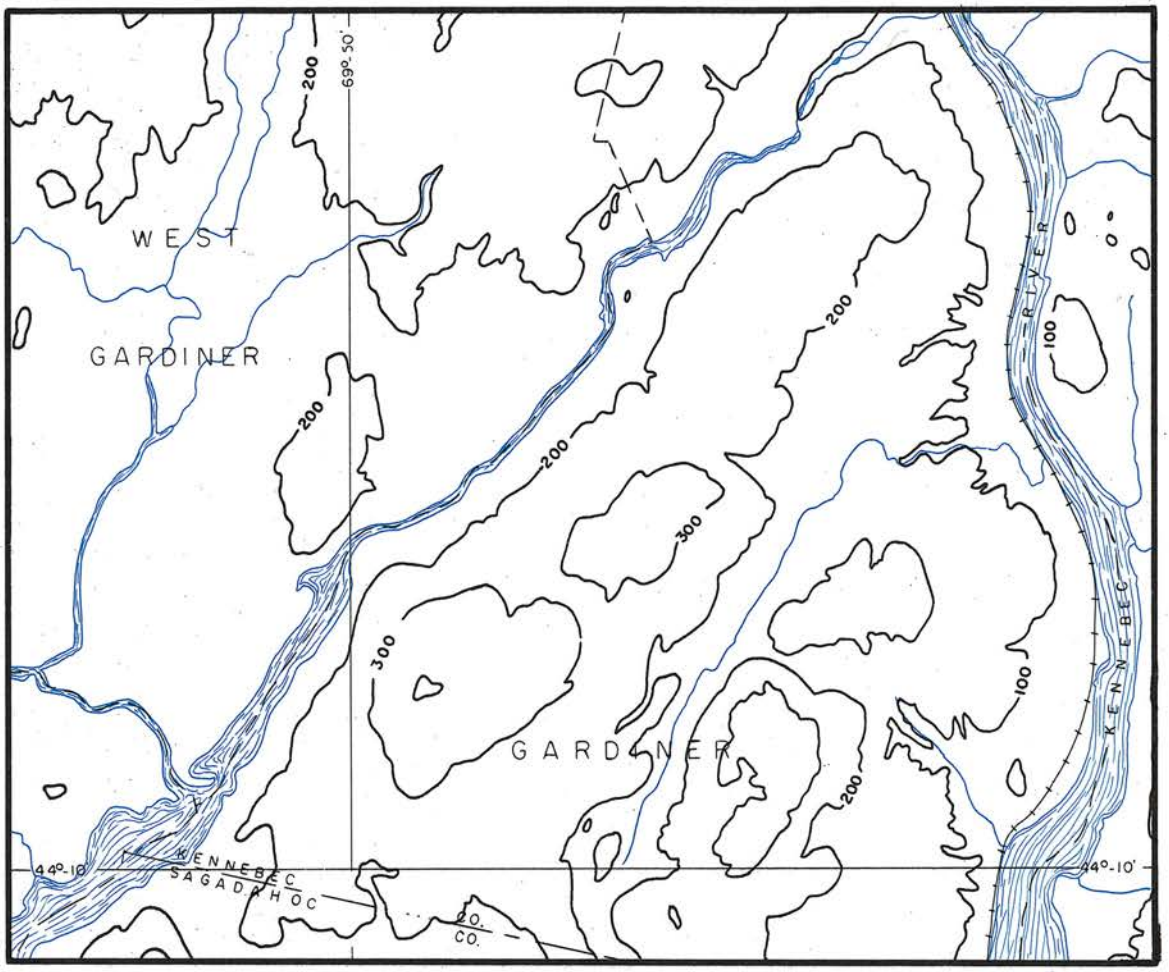
MAP APPENDIX II

GARDINER AREA

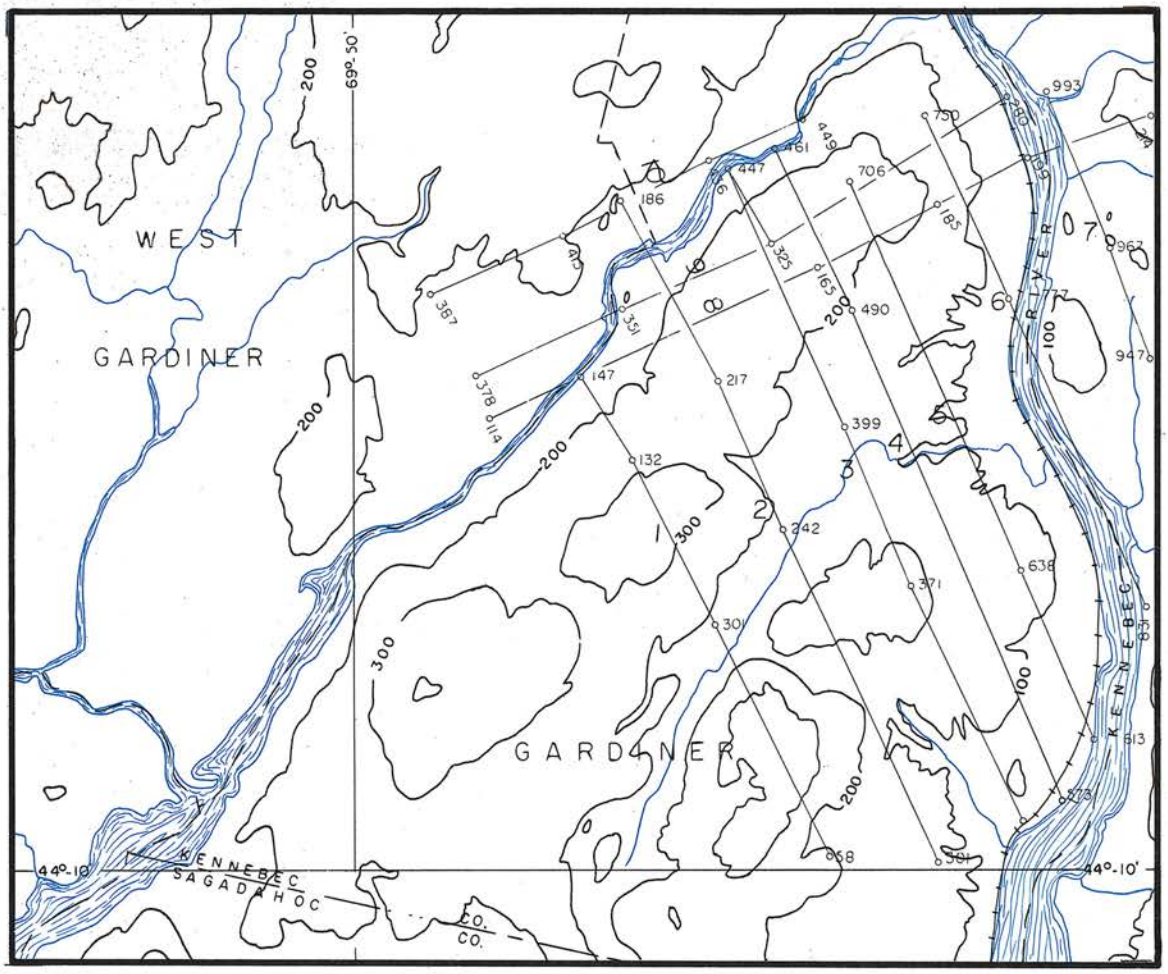


GARDINER, MAINE

BASE SHEET

C.I. = 100

R.F. = 1:62,500



GARDINER, MAINE

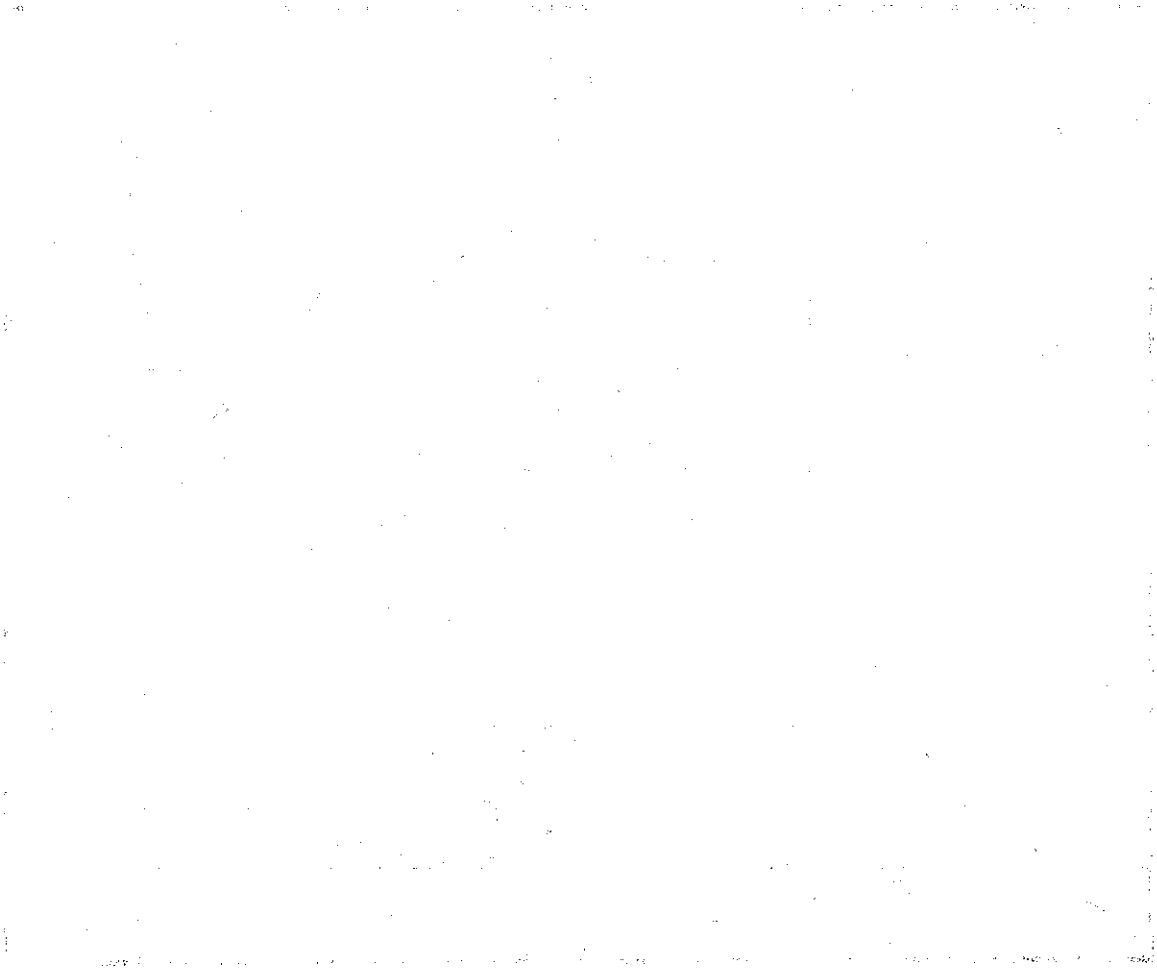
FLIGHT LINE SHEET

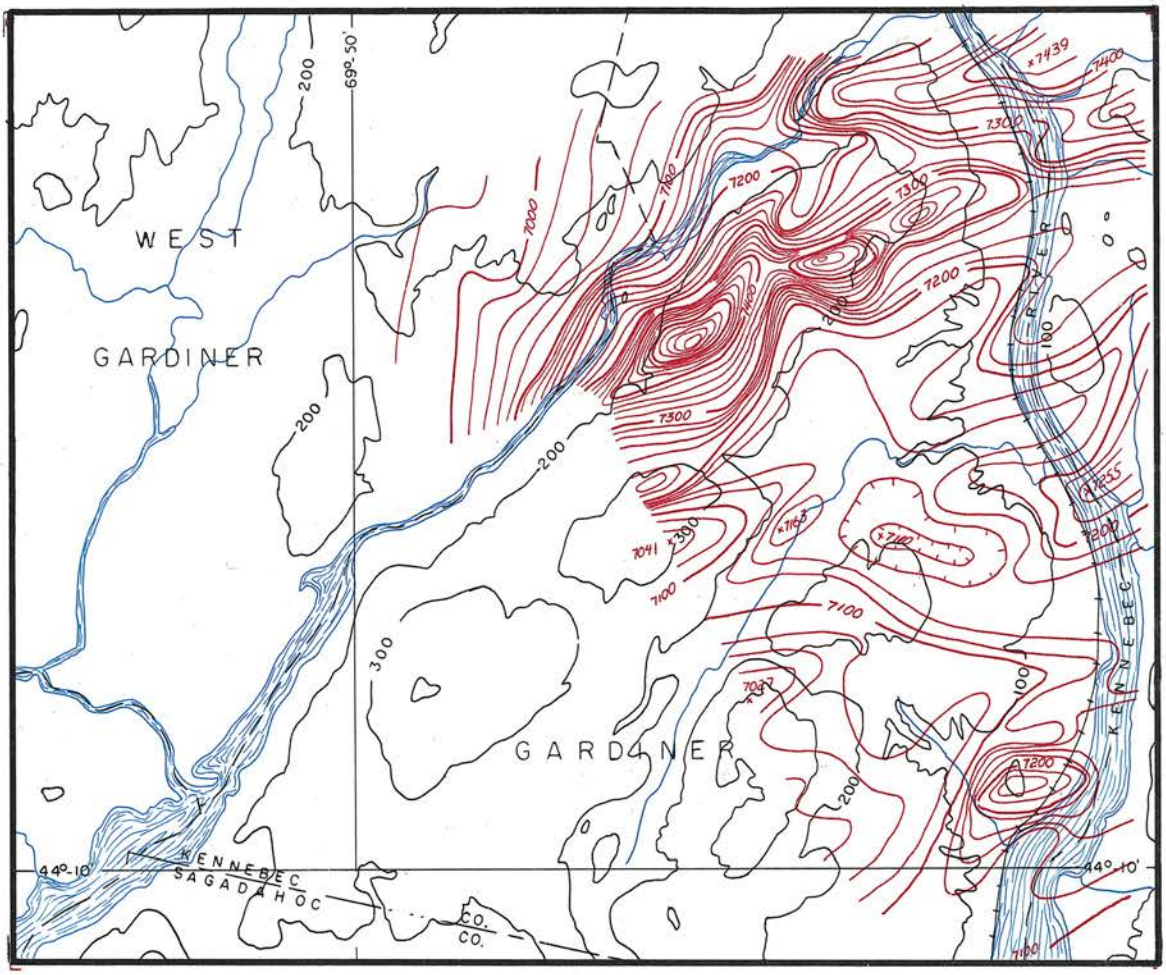
18°
mag.
1945

0 1 2
miles

C.I. = 100

R.F. = 1:62,500





MAGNETIC SHEET

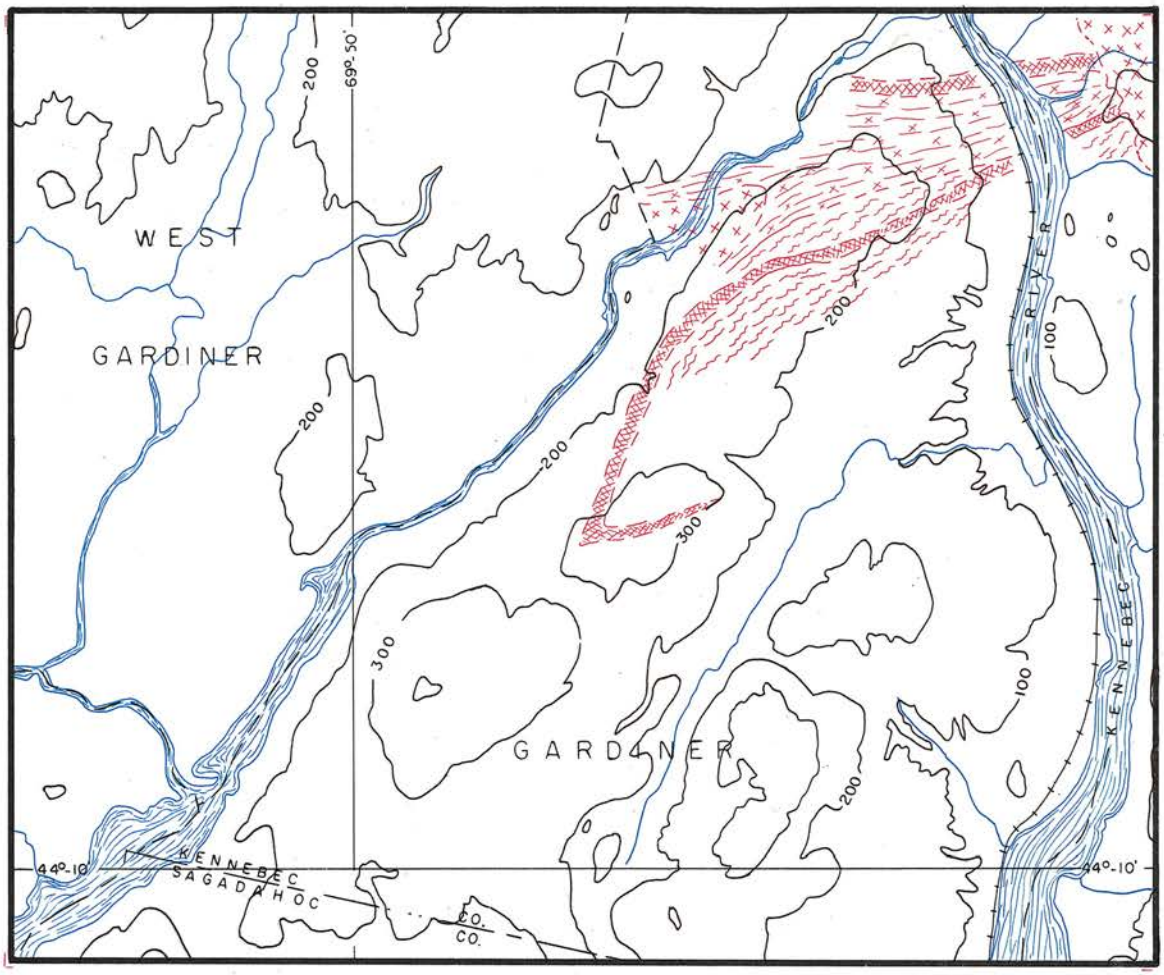
Flight altitude 500 feet above terrain
Flight interval 0.25 to 0.50 miles

approx. inclination and total intensity

approx. mean declination 1959

REGIONAL MAGNETIC VALUES

Contour interval 20 gammas based on total intensity less 50,000 gammas



GEOLOGIC SHEET

- Binary granite
- Granitic gneiss
- Pyrrhotite - pyrite schist
- Quartz - biotite schist
- Geologic boundary, observed
- Geologic boundary, inferred